California Regional Water Quality Control Board
Santa Ana Region

June 4, 2004

ITEM: **14**

SUBJECT: **Public Workshop: Proposed Basin Plan Amendment – Incorporation of Total Maximum Daily Loads (TMDLs) for Nutrients for Lake Elsinore and Canyon Lake**

California Regional Water Quality Control Board

Santa Ana Region

LAKE ELSINORE and CANYON LAKE NUTRIENT TOTAL MAXIMUM DAILY LOADS

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Clean Water Act Section 303(d) requires that States identify waters that do not or are not expected to meet water quality standards (beneficial uses, water quality objectives) with the implementation of technology-based controls. Once a waterbody has been listed on the 303(d) list of impaired waters, states are then required to develop a Total Maximum Daily Load (TMDL) for the pollutant causing impairment. A TMDL is defined as the sum of the individual waste load allocations for point sources, load allocations for nonpoint sources and a margin of safety. TMDLs must also address seasonal variations and natural background. In 1994, the Regional Board identified Lake Elsinore as impaired due, in part, to excessive levels of nutrients. In 1998 and 2002, the Regional Board listed Canyon Lake on the 303(d) list due to eutrophication and pathogens. Lake Elsinore was included in the 1998 and 2002 303(d) lists due to nutrients, organic enrichment/low dissolved oxygen, sedimentation/siltation, and unknown toxicity. As a result of the listings, the Regional Board initiated the development of TMDLs for nutrients for these two lakes. TMDL development for other pollutants is on-going and the recommendations will be made to the Regional Board at a later date.

This report provides the basis for the recommendation that the Regional Board consider changes to the Implementation Plan (Chapter 5 of the Water Quality Control Plan or Basin Plan) to incorporate the nutrient TMDLs for Canyon Lake and Lake Elsinore. In summary, Resolution No. RB8-2004-0037 would amend the Basin Plan to incorporate nutrient TMDLs for Lake Elsinore and Canyon Lake that include the following components: problem statement; interim and final numeric targets; source analysis; wasteload allocations for point source discharges; load allocations for nonpoint source discharges; implementation plan and schedule for compliance with the TMDL; and a monitoring program for determining the effectiveness of the TMDL.

1. Introduction

The Santa Ana Regional Water Quality Control Board (Regional Board) is the California State agency responsible for water quality protection in the Santa Ana River Watershed. It is one of nine Regional Boards that function as part of the California State Water Resources Control Board (State Board) system within the California Environmental Protection Agency. The Santa Ana Regional Board implements both the federal Clean Water Act and the Porter-Cologne Water Quality Control Act, part of the California Water Code. Water quality standards and control measures for waters of the Santa Ana Region are contained in the 1995 *Water Quality Control Plan for the Santa Ana River Basin (*Basin Plan).

Under Section 303(d) of the Clean Water Act, the Regional Board is required to identify surface waters that do not or are not expected to meet water quality standards (beneficial uses, water quality objectives) with the implementation of technology-based controls. Once a waterbody has been listed on the 303(d) list of impaired waters, Regional Boards then must develop strategies called "Total Maximum Daily Loads" (TMDLs), for the pollutant causing impairment. TMDLs are composed of the sum of the Wasteload Allocations (WLA) for point source discharges, the sum of the Load Allocations (LA) for nonpoint source discharges, and a Margin of Safety (MOS). This can be expressed by the equation:

$$TMDL = \Sigma WLA + \Sigma LA + MOS$$

The WLA and LA can be for existing sources, future sources or a combination of both. The MOS takes into account the lack of knowledge or data concerning the relationship between the WLAs and LAs and resulting water quality. The margin of safety can either be incorporated implicitly through conservative analytical approaches and assumptions used to develop the TMDL, or added explicitly as a separate component of the TMDL (USEPA, 1999).

Lake Elsinore and Canyon Lake are located at the terminus of the San Jacinto River Watershed in southwestern Riverside County. The entire San Jacinto River watershed encompasses 780 square miles. Lake Elsinore is one of the few natural lakes in southern California. It was formed in a geologically active graben area and has been in existence over thousands of years. Due to the mediterranean climate and watershed hydrology, lake level fluctuations in Lake Elsinore have been extreme, with alternate periods of a dry lake bed and extreme flooding. These drought/flood cycles have a great impact on lake water quality. Fish kills and excessive algae blooms have been reported in Lake Elsinore since the early 20th century. As a result, in 1994, the Regional Board placed Lake Elsinore on the 303(d) list of impaired waters due to excessive levels of nutrients.

Canyon Lake, located approximately five miles upstream of Lake Elsinore, was formed by the construction of Railroad Canyon dam in 1928. Approximately 735 square miles of the 780 square mile San Jacinto River watershed drains to Canyon Lake. Only in wet years does Canyon Lake overflow to Lake Elsinore; during most years, runoff from the watershed terminates at Canyon Lake without reaching Lake Elsinore, resulting in the buildup of nutrients in Canyon Lake. While Canyon Lake does not have as severe an eutrophication problem as does Lake Elsinore, there have been periods of algal blooms and occasional fish kills (anecdotal evidence, no written documentation, please see Section 3.0, Problem Statement). In 1998, the Regional Board added Canyon Lake to the 303(d) list of impaired waters due to eutrophication.

In October 2000 staff prepared the "Lake Elsinore Nutrient TMDL Problem Statement". In October 2001, staff prepared the "Canyon Lake Nutrient TMDL Problem Statement". These reports provided descriptions of the San Jacinto River Watershed, including geological and hydrological features, land uses, summaries of historical and current water quality conditions in both lakes, and existing applicable water quality standards established in the 1995 Basin Plan. The reports documented that the beneficial uses of the lakes were impaired by excessive amounts of nutrients (phosphorus and nitrogen) and provided preliminary recommendations for numeric targets to be achieved to assure that the beneficial uses of both lakes would be protected. Based on additional data and studies, the numeric targets proposed in both the Lake Elsinore and Canyon Lake Problem Statements have been revised in this report. The Lake Elsinore and Canyon Lake Problem Statements provide important background information relative to the final development of the proposed nutrient TMDLs.

Since the completion of the Lake Elsinore and Canyon Lake Problem Statements, the following studies have been conducted:

- Internal Nutrient Load Quantification – UC Riverside conducted studies to quantify the internal nutrient loading from Lake Elsinore and Canyon Lake sediments, as well as the response of the lakes to these internal nutrient loadings. Funding support for these studies came from the State's TMDL program.

- Lake Elsinore and Canyon Lake In-lake Water Quality Monitoring – Regional Board staff and watershed stakeholders have conducted in-lake monitoring since May 2000 to evaluate the current nutrient cycling processes and to determine the Lakes' response to nutrient loads from the watershed. The in-lake monitoring data were also used to characterize the spatial and temporal trends of nutrients, algal biomass, dissolved oxygen, and other water quality parameters.

- Watershed Monitoring – In order to determine sources of nutrients in the watershed, Regional Board staff and watershed stakeholders implemented an extensive watershed-wide monitoring program. The watershed monitoring program focused on assessing nutrient loadings from various identified land uses in the watershed. Funding support for both the Watershed Monitoring Program and the In-Lake Monitoring Program came from the Lake Elsinore and San Jacinto Watersheds Authority (LESJWA)[1]

- Nutrient Watershed Modeling –Through a Clean Water Act Section 205(j) grant, LESJWA funded a watershed modeling effort to simulate nutrient loads under different hydrologic conditions and to assess the impact of various implementation plans on the water quality of Lake Elsinore and Canyon Lake.

- Lake Users Survey – LESJWA conducted a lake users survey from April through September 2002 in order to link lake users' opinions of Lake Elsinore to water quality parameters. Board staff conducted water quality monitoring on the same days the Lake Users Surveys were conducted in order to provide this linkage.

The above mentioned studies have helped to better define the nutrient dynamics in both Canyon Lake and Lake Elsinore, as well as to identify sources of nutrients to the lakes. As a result, the numeric targets proposed in the Lake Elsinore and Canyon Lake Problem Statements have been refined. The studies also allowed Board staff to establish the linkage between the proposed numeric targets and load capacity of the lakes, and to evaluate the effectiveness of possible TMDL implementation scenarios.

The purpose of this document is to provide the technical basis for the proposed TMDL. It includes the TMDL elements of problem statement, selection of water quality indicators and numeric targets, sources assessment, linkage analysis to determine load capacity, phosphorus and nitrogen TMDL, and wasteload and load allocations. Seasonal variations are considered in the source assessment and when load capacity is calculated. A margin of safety is also incorporated into the development of numeric targets and TMDL allocations. Finally, an implementation plan and schedule and a monitoring program are proposed in this document.

As in the case of many TMDLs, this TMDL is proposed to be developed, refined and implemented in a phased manner. The phased approach is appropriate when the pollutant problem is complex and there is uncertainty in the ability to adequately characterize and analyze pollutant impacts on receiving waters. For the Lake Elsinore and Canyon Lake nutrient TMDL, there are data gaps and uncertainty in understanding the nutrient and hydrologic regimes in the watershed. For instance, because TMDL development was initiated during a relatively dry period, there are no data to confirm assumptions made about nutrient loads in the watershed under wet conditions, or how the lakes may respond to these nutrient loadings. Furthermore, without specific implementation and testing of implementation practices, the effectiveness of in-lake treatment and watershed management practices is uncertain. Staff recommends that this TMDL be revised

[1]The Lake Elsinore and San Jacinto Watersheds Authority (LESJWA) was formed in 2000 with the passage of Proposition 13. One of the provisions in the bond was an award of $15 million for restoration of Lake Elsinore and the San Jacinto River Watershed. LESJWA, a Joint Powers Agency, was formed to manage and plan for Lake and watershed restoration activities using these funds. The members of LESJWA include the City of Lake Elsinore, the City of Canyon Lake, Santa Ana Watershed Project Authority (SAWPA), the County of Riverside, and Elsinore Valley MWD.

periodically as new monitoring data become available, the understanding of nutrient dynamics in relationship to the lake ecosystem improves, and as the effectiveness of various management practices is evaluated.

2. Watershed Overview

Lake Elsinore and Canyon Lake lie 60 miles southeast of Los Angeles and 22 miles southwest of the City of Riverside. Lake Elsinore is located within the City of Lake Elsinore in Riverside County, and is a natural low point of the San Jacinto River and its drainage basin (Figure 2-1). The total drainage area of the San Jacinto River watershed is approximately 782 square miles. Over 90 percent of the watershed (735 square miles) drains into Railroad Canyon Reservoir (Canyon Lake). Lake Elsinore is the terminus of the San Jacinto River watershed. The local tributary area to Lake Elsinore, consisting of drainage from the Santa Ana Mountains and the City of Lake Elsinore, is 47 square miles.

2.1 San Jacinto River Watershed – Geological and Hydrological Features

The San Jacinto River watershed is bounded by two strike-slip fault zones, the San Jacinto fault zone to the northeast and the Elsinore fault zone to the southwest. The San Jacinto Valley is among the most seismically active of the major strike-slip fault zones in southern California, and also the site of rapid subsidence (20 mm per year) due to tectonic activity and groundwater withdrawal (Morton, 1999). The rapid rate of subsidence has resulted in the formation of a strike-slip "pull-apart basin" or graben that has developed along parallel fault strands in the fault zone. The Elsinore fault zone is also a strike-slip fault zone and the subsidence along the fault formed Lake Elsinore.

As shown in Figure 2-1, flow to the San Jacinto River begins in the San Jacinto Mountains. Water flows down the San Jacinto Mountains and then northwest along the San Jacinto fault zone. Most of the flows from the mountain infiltrates into groundwater during low flow years. The high subsidence rate of the San Jacinto Valley along the fault zone has resulted in a closed depression that periodically fills with water to form the ephemeral Mystic Lake. In very wet years, the surface area of Mystic Lake can expand up to 400 acres. The river makes a 90-degree turn and flows southwest at Mystic Lake. The very low river gradient westward from Mystic Lake forms a broad fluvial plain. The River then flows through the narrow Railroad Canyon, Canyon Lake, and exits the Perris Block into the lower Elsinore basin created by the Elsinore fault zone.

The major waterbodies and tributaries of the San Jacinto River watershed include Lake Hemet, Strawberry Creek, Bautista Creek, Mystic Lake, Perris Valley Storm Drain, Salt Creek, Canyon Lake (Railroad Canyon Reservoir), and Lake Elsinore.

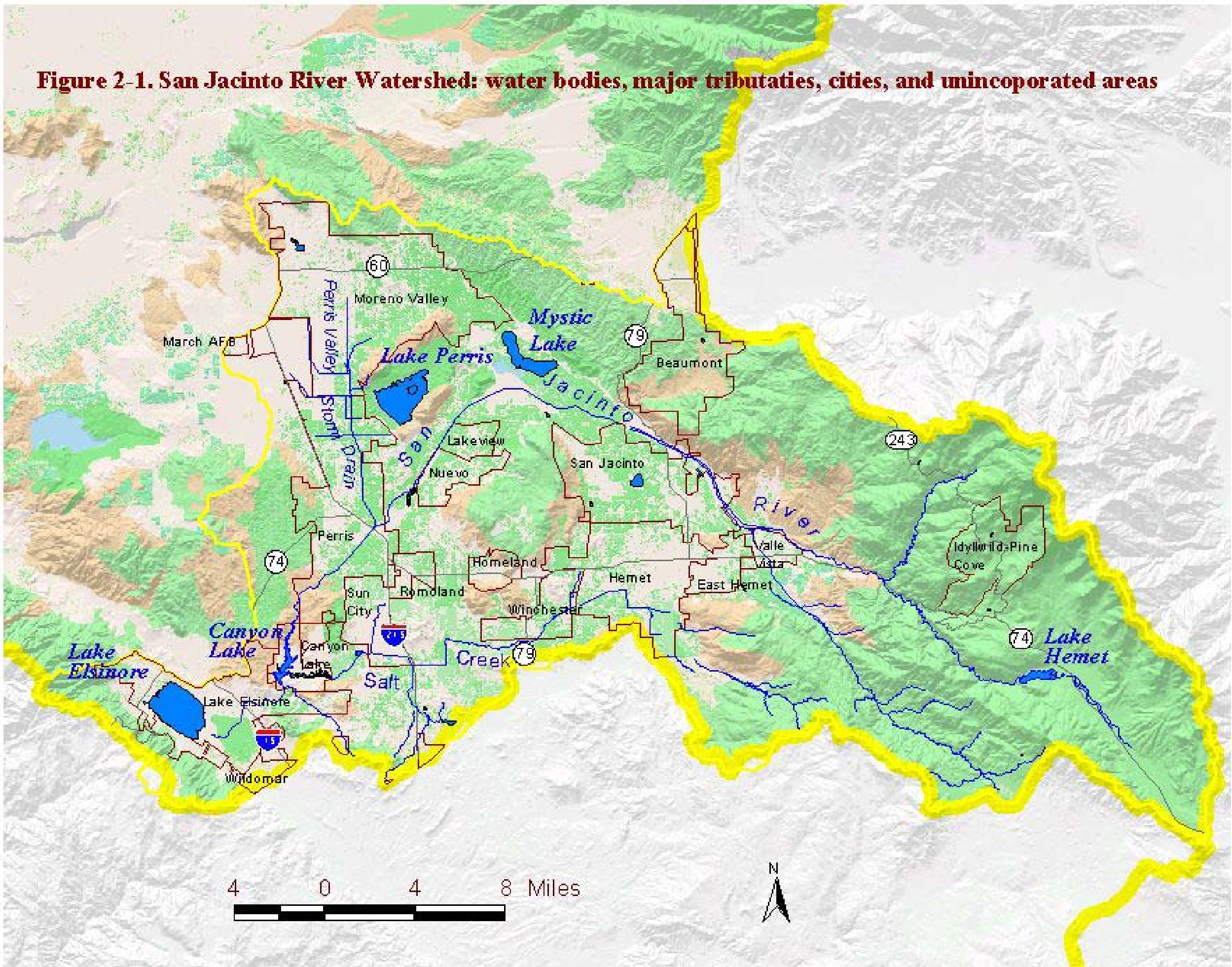

Figure 2-1. San Jacinto River Watershed: water bodies, major tributaties, cities, and unincoporated areas

The San Jacinto River channel has been heavily altered for flood control, farming, and water supply purposes. Early in the 20th century, the U.S. Army Corps of Engineers and the Riverside County Flood Control and Water Conservation District constructed a levee along the San Jacinto River north of the City of San Jacinto to provide flood protection. Construction of the levee resulted in the accumulation of sediment in the river channel, causing the river bed to be at a higher elevation than the City, thereby exacerbating the flooding potential. Farmers in the watershed have diverted flow away from its natural path into Mystic Lake, leaving the old river bed dry. The new river channel bypasses the graben basin, thus cutting off the sediment supply that would have compensated for the rapid subsidence. Consequently, the area of the depression is expanding. Groundwater in the basin has also been withdrawn for agricultural and domestic supply purposes in the last century. As a result of all of the human engineering activities affecting the San Jacinto River, the surface flow in the River has been significantly reduced. Only in wet years does water from the San Jacinto River reach Canyon Lake and Lake Elsinore.

2.2 Land Use

The majority of land in the San Jacinto basin consists of federal, state, or privately owned open space areas. According to 1993 landuse data from the Southern California Association of Governments (SCAG), land use in the watershed includes vacant land (66%), agricultural land (18%, including Confined Animal Operations such as dairies and chicken ranches, and irrigated cropland), and residential (9%) (Table 2-1). Vacant/open space is being converted to residential uses as the population in the area expands. The municipalities in the watershed include the cities of San Jacinto, Hemet, Perris, Canyon Lake, Lake Elsinore and portions of Riverside, Moreno Valley, Beaumont and Murrieta (see Figure 2-1).

Table 2-1 San Jacinto Watershed 1993 Land Use[2]

Land Use Classification	Acres	Total %
Vacant	304,194	66
Agricultural	83,157	18
Residential	41,521	9
Military	5,745	1
Transportation & Utilities	4,867	1
Water & Flood Plain	3,688	1
Open Space and Preserve	2,954	1
Commercial	2,256	0.5

Data source: Montgomery Watson, 1996 (based on the SCAG 1993 data)

[2] This is the most recent published land use data available to Regional Board staff.

2.3 Characteristics of Lake Elsinore

Lake Elsinore is a relatively shallow lake with a large surface area. At the current lake outlet sill elevation of 1,255 feet, the lake has an average depth of 24.7 feet and a surface area of 3500 acres. Annual average precipitation in the Lake Elsinore watershed is approximately 11.6 inches; average annual evaporative loss is 56.2 inches (Montgomery & Watson, 1997). This excessive evaporation loss compared to natural inflow results in very low lake levels. As shown in Figure 2-2, at the extreme, Lake Elsinore was completely dry in the 1950s and 1960s. Only in extremely wet years does Lake Elsinore overflow into Temescal Creek. In the last century, Lake Elsinore only overflowed seven times, causing extensive flooding to the City of Lake Elsinore. Since 1998, the lake elevation has been declining steadily (Figure 2-3).

To prevent the lake from drying out and also to mitigate the flooding potential, the U.S. Bureau of Land Management, the U.S. Army Corps of Engineers and the County of Riverside Flood Control and Water Conservation District developed the Lake Elsinore Management Project (LEMP). Three major projects were implemented through the LEMP: 1) construction of a levee to separate the main lake from the back basin to reduce the lake surface area and thereby prevent significant evaporative losses; 2) realignment of the lake inlet channel to bring natural runoff from the San Jacinto River; and, 3) lowering of the lake outlet channel to increase outflow to Temescal Creek when the lake level exceeds an elevation of 1,255 feet. The LEMP also called for the introduction of supplemental makeup water to maintain lake levels at an adopted operation range of 1,240 to 1,249 feet.

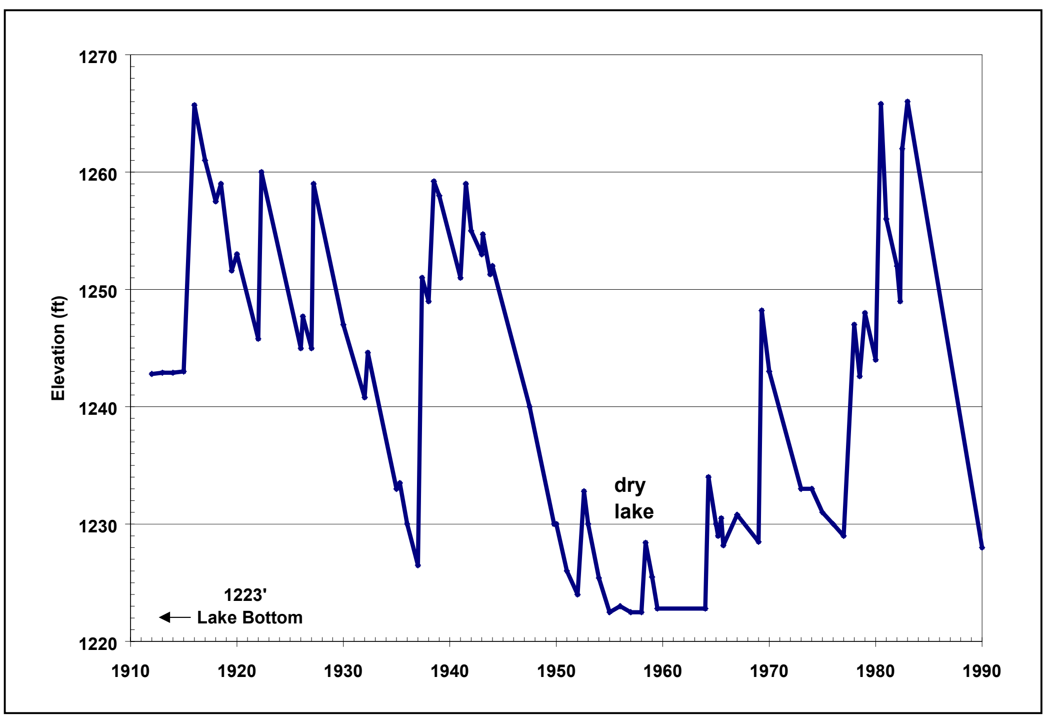

Figure 2-2. Lake Elsinore elevation from 1912 through 1990

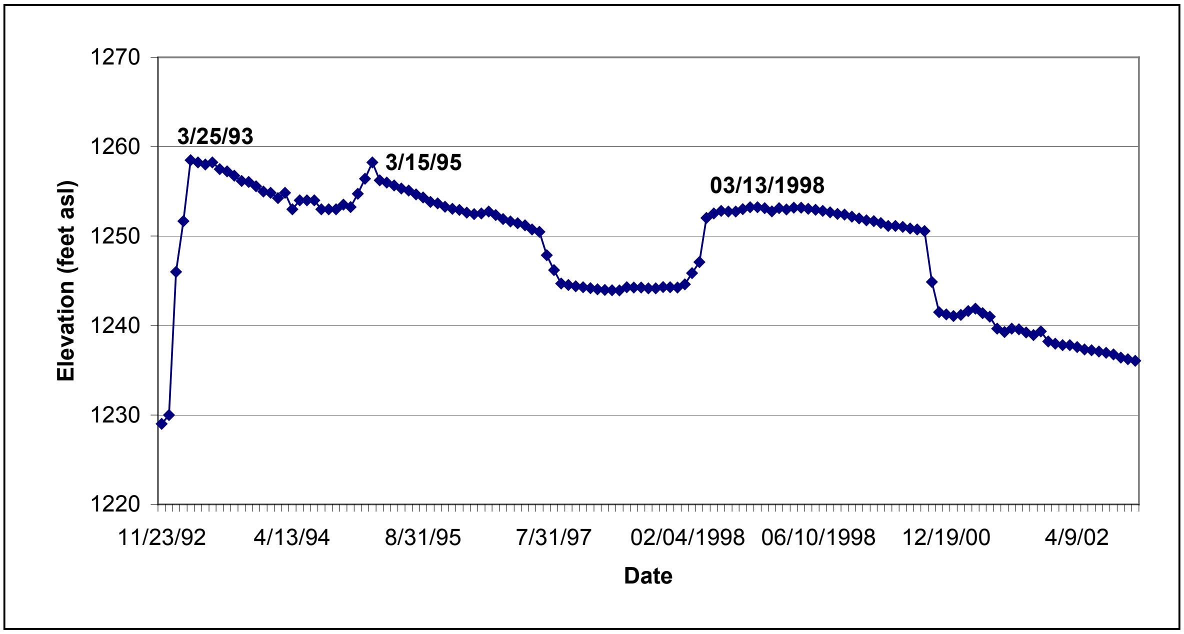

Figure 2-3. Lake Elsinore elevation from 1992 to 2002

2.4 Characteristics of Canyon Lake

Canyon Lake, also known as Railroad Canyon Reservoir, was constructed in 1928 by the Temescal Water Company. The lake was constructed to store water from the San Jacinto River for agricultural irrigation in the area. The surface area of Canyon Lake is approximately 500 acres, with a storage capacity of 11,900 acre-feet. The Railroad Canyon Reservoir dam is located approximately five miles upstream from Lake Elsinore. Approximately 735 square miles of the San Jacinto River watershed drains into Canyon Lake before reaching Lake Elsinore. During most years, drainage from the San Jacinto River watershed terminates at Canyon Lake without reaching Lake Elsinore. In the last decade, the only significant overflows from Canyon Lake to Lake Elsinore occurred in 1993, 1995, and 1998. The San Jacinto River drains to the north part of Canyon Lake. Salt Creek, the other major tributary, drains to the east part of the lake (Figure 2-4)

After construction of the Railroad Canyon Reservoir dam by the Temescal Water Company, Corona Land Company developed the land surrounding Canyon Lake. The lake and the fringe of land around it were owned by the Temescal Water Company and leased to the Canyon Lake Property Owners Association (POA) for recreational purposes. Subsequently, Elsinore Valley Municipal Water District (EVMWD) bought the Temescal Water Company, and in 1989, EVMWD entered into a contract to acquire the lake and these leases. The agreement between EVMWD and the Canyon Lake POA requires that the minimum lake elevation be kept at 1372 ft above sea level. The spillway elevation of the dam is at 1381.76 ft above sea level. In the last decade, EVMWD has supplemented the lake with water imported from the Colorado River to maintain the required water level.

In December 1990, the City of Canyon Lake was incorporated. For the most part, use of the lake is limited to City residents; public access is available north of the North Causeway (See Figure 2-4).

In addition to recreational uses, Canyon Lake is also a source of drinking water. EVMWD draws water from Canyon Lake (near the dam) and treats it at the Canyon Lake Water Treatment Plant, before delivery to the District's customers. Water from Canyon Lake comprises approximately one quarter of the total water supply of the EVMWD service area (Julius Ma, EVMWD, oral communication).

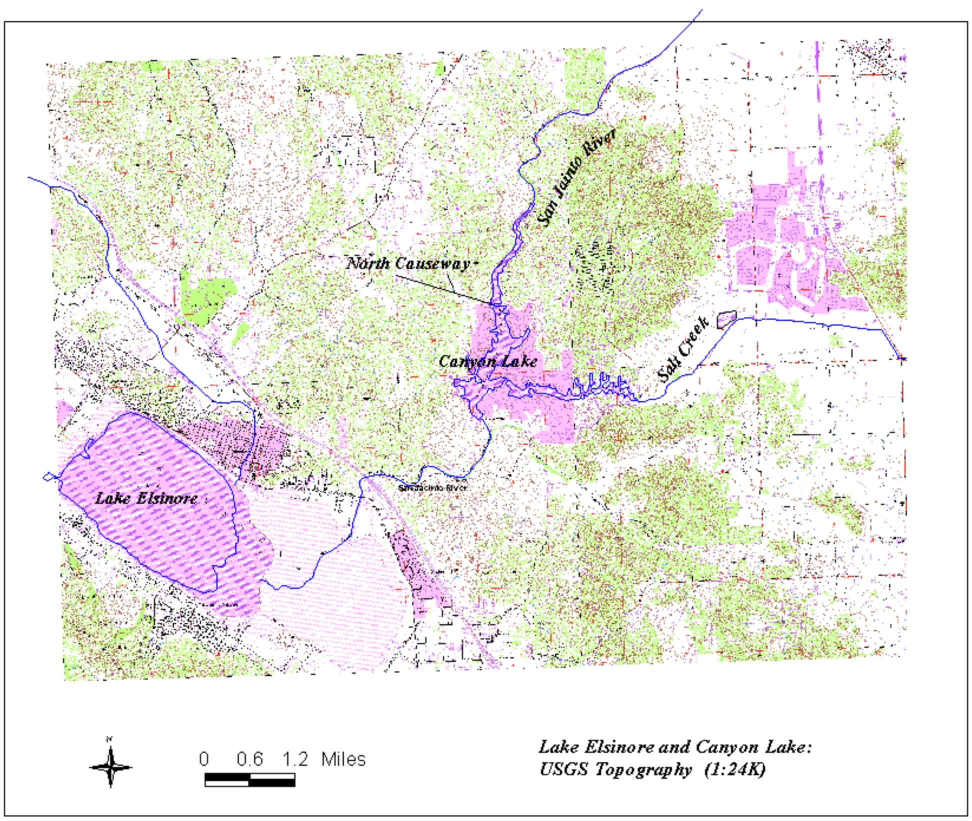

Figure 2-4. Lake Elsinore and Canyon Lake

2.5 Lake Elsinore and Canyon Lake Beneficial Uses and Water Quality Objectives

The beneficial uses of Lake Elsinore as identified in the 1995 Water Quality Control Plan for the Santa Ana River Basin (Basin Plan) are as follows:

- Warm Freshwater Aquatic Habitat – **(WARM)**
- Body Contact Recreation – **(REC1)**
- Non Body Contact Recreation – **(REC2)**
- Wildlife Habitat – **(WILD)**

The Basin Plan specifies both numeric and narrative water quality objectives for Lake Elsinore that relate to nutrient impairment. These objectives are as follows:

- Total Inorganic Nitrogen (**TIN) –** 1.5 mg/L[3]

- Algae – Waste discharges shall not contribute to excessive algal growth in receiving waters.

- Un-ionized Ammonium-N (UIA)[4]:
  Acute (1-hour) Objective = 0.822 [0.87/FT/FPH/2]
  Chronic (4-day) UIA-N Objective = 0.822 [0.87/FT/FPH/RATIO]
  (Please see the 1995 Basin Plan pg. 4-5 and 4-6 for explanation of FT, FPH and RATIO)

- Dissolved Oxygen – the dissolved oxygen content of surface waters shall not be depressed below 5 mg/L for waters designated **WARM**

The beneficial uses of Canyon Lake as identified in the 1995 Water Quality Control Plan for the Santa Ana River Basin (Basin Plan) are as follows:

- Municipal and Domestic Water Supply **(MUN)**
- Agriculture Water Supply **(AGR)**
- Groundwater Recharge **(GWR)**
- Body Contact Recreation – **(REC1)**
- Non Body Contact Recreation – **(REC2)**
- Warm Freshwater Aquatic Habitat – **(WARM)**
- Wildlife Habitat – **(WILD)**

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[3] TIN is the sum of nitrate, nitrite and ammonia forms of nitrogen. The TIN water quality objective was established based on the TIN historical average in the lake prior to 1975. Given the eutrophication problems in Lake Elsinore, Regional Board staff believes this value may not be protective of the WARM beneficial use and may need to be revised (See Section 4.0, Numeric Targets for detailed discussion).

[4] The UIA objectives specified in the Basin Plan have not been approved by US EPA. US EPA recommends that these objectives be reviewed and revised based on the US EPA's revised national ammonia criteria. A review of the UIA objectives was included on the Regional Board's 2002 Triennial Review list. In light of US EPA's recommendation and, as discussed in Section 4.3, staff proposes to rely on the national UIA criteria for this TMDL.

The Basin Plan specifies both numeric and narrative water quality objectives for Canyon Lake that relate to nutrient impairment. These objectives are as follows:

- TIN -- 8 mg/L [5]

- Algae – Waste discharges shall not contribute to excessive algal growth in receiving waters.

- Un-ionized Ammonium-N (UIA):
  Acute (1-hour) Objective = 0.822 [0.87/FT/FPH/2]
  Chronic (4-day) UIA-N Objective = 0.822 [0.87/FT/FPH/RATIO]
  (Please see the 1995 Basin Plan pg. 4-5 and 4-6 for explanation of FT, FPH and RATIO)

- Dissolved Oxygen – the dissolved oxygen content of surface waters shall not be depressed below 5 mg/L for waters designated **WARM.**

The Basin Plan does not specify phosphorus water quality objectives for Lake Elsinore or Canyon Lake, yet both nitrogen and phosphorus concentrations affect algae growth in these lakes. Therefore, staff recommends that the nutrient TMDLs include both nitrogen and phosphorus components.

[5] The 8mg/L TIN objective for Canyon Lake is intended to protect the MUN beneficial use. However, given the eutrophication problems in Canyon Lake, Regional Board staff believes that this value may not be protective of the WARM beneficial use and may need to be revised.

3. Lake Elsinore and Canyon Lake Nutrient TMDL Problem Statement

3.1 Lake Elsinore

As detailed in the October 2000 Lake Elsinore Nutrient TMDL Problem Statement, the most distinct water quality problem affecting Lake Elsinore is hypereutrophication. The hypereutrophic condition arises due to an enrichment of the Lake with nutrients (phosphorus and nitrogen), resulting in high algal productivity (mostly planktonic algae). Algae respiration and decay depletes available water column oxygen, resulting in adverse effects on aquatic biota, including fish. As shown in Table 3-1, Lake Elsinore has a long history of reported algal blooms and resulting fish kills (Tilley Agreement, 1927, EDAW Inc., 1974)[6]. In all cases, the cause cited for the fish kills was the depletion of oxygen in the water column. The decay of dead algae and fish also produces offensive odors and an unsightly lakeshore, adversely affecting use of the lake for recreational purposes. In addition, the massive amount of algal cells in the water column has caused high turbidity in the lake, making the water an uninviting murky green color at times.

Comparing the fish kill record to rainfall and lake levels, it appears that fish kills coincide with either very shallow lake levels or high flows from the watershed due to heavy rainfall events. This indicates that lake levels and inputs of nutrients to the lake estimated to occur during very wet conditions are both important factors that affect the health of Lake Elsinore.

As a result of the history of fish kills and algal blooms in Lake Elsinore, in 1994, the Regional Board placed Lake Elsinore on the Clean Water Act Section 303(d) list of impaired waterbodies. In 1998 and 2002, Lake Elsinore was listed for unknown toxicity, nutrients, organic enrichment/low dissolved oxygen and sedimentation/siltation. It has been determined that, for Lake Elsinore, warm freshwater aquatic habitat (WARM) and water contact and non-water contact recreation (REC1 and REC2) are the beneficial uses that are impaired by the nutrient levels.

[6] It is possible that additional fish kills occurred that are not shown on the Table 3-1. What is tabulated reflects the fish kill records that were available to Regional Board staff.

Table 3-1. Fish Kill Record in Lake Elsinore

Year	Description
1933	Fish kill and algal bloom in April reported by State Bureau of Sanitary Engineering
1940	Fish kill reported by State Bureau of Fish Conservation
1941	Fish kill reported by State Department of Fish and Game
1948	300-500 tons of carp died from Aug. 31-Sept. 2? -reported by State Department of Fish and Game
1950	"There are no fish in the Lake" -reported by Riverside County Health Department
1966	"An extensive die-off of fish" -reported by State Department of Fish and Game
1972	"During the last week of August, and continuing through September, tons of fish were buried or taken to the dump, mostly thread-fin shad" -reported by State Department of Fish and Game
1991	120 thousands tons of fish killed by algae – reported by The Press Enterprise
1992	12-15 tons fish kill on August 17 – reported by The Press Enterprise
1993	More than 100,000 tons of fish died - reported by Black & Veatch (1996)
1995	10 tons of fish killed, shad and bluegill in September – reported by The Press Enterprise
1996	small fish die-off in August – reported by The Press Enterprise
1997	7 tons of shad died of oxygen depletion in April – reported by The Press Enterprise
1998	200 tons fish kill - reported by The Press Enterprise
2002	100 tons of fish kill - reported by The Press Enterprise

Sources: EDAW Inc., 1974, Press Enterprise Reports, and LEMA, 1996

3.2 Canyon Lake

Similar to Lake Elsinore, eutrophication has caused water quality problems in Canyon Lake. Excessive input of nutrients (phosphorus and nitrogen) has resulted in high algal productivity. The decay of dead algae produces offensive odors and an unsightly lakeshore, adversely affecting use of the lake for water-contact and non-contact recreational purposes (REC1 and REC2). In addition, the high amount of algal cells causes high turbidity in the lake, also making Canyon Lake an uninviting murky green color at times. Canyon Lake experiences periods of oxygen depletion due to algae respiration and decomposition that can result in fish kills, adversely affecting the warm water aquatic habitat beneficial use (WARM)[7].

As previously mentioned, Canyon Lake serves as a domestic water supply to EVMWD customers. EVMWD extracts water from Canyon Lake and treats the water at the Canyon Lake Water Treatment Plant prior to delivery to its customers. The eutrophic conditions in Canyon Lake impact the MUN beneficial use. Low oxygen levels result in high concentrations of manganese and iron in the hypolimnion. When manganese levels in the water column exceed 0.45 mg/L, EVMWD shuts down the water treatment plant. The high algal productivity also

[7] Unlike Lake Elsinore, Board staff could find no written record of fish kills for Canyon Lake; anecdotal information indicates that there have been fish kills. The fact that dissolved oxygen levels in Canyon Lake can be as low as 0% saturation indicates the threat of nutrient input to the WARM beneficial use.

necessitates periodic shutdown of the Canyon Lake Water Treatment Plant because algal cells can clog the water treatment filters.

The Regional Board placed Canyon Lake on the 303(d) list of impaired waters in 1998 and 2002 due to excessive nutrients levels. The municipal water supply (MUN), warm water aquatic habitat (WARM), and water contact and non-water contact recreation (REC1 and REC2) uses of Canyon Lake are the beneficial uses that are impaired by nutrients.